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Before the  
**FEDERAL COMMUNICATIONS COMMISSION**  
Washington, D.C. 20554

In the Matter of )  
 )  
Current Trends in LTE-U and LAA Technology ) ET Docket No. 15–105  
 )  
  
To: Office of Engineering and Technology  
Wireless Telecommunications Bureau

**COMMENTS OF ERICSSON**

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Ericsson submits these comments in response to the May 5, 2015, Public Notice seeking information on current trends in LTE-Unlicensed (“LTE-U”) and Licensed Assisted Access Using LTE (“LAA”) technology.<sup>1</sup>

**I. INTRODUCTION AND SUMMARY**

Ericsson supports both licensed and unlicensed platforms and integrates both types of solutions in our product offerings to customers. Ericsson is a member of, and contributor to, all of the technological development and standards groups furthering both licensed and unlicensed platforms (*e.g.*, the Third Generation Project (“3GPP”), the Institute of Electrical and Electronics Engineers (“IEEE”) and its many working groups, and the Wi-Fi Alliance (“WFA”)). We support the advancement of LTE-U/LAA, we support Wi-Fi, and we are committed to continued innovation and equitable access for multiple technologies using unlicensed platforms.

LTE-U/LAA will allow a mobile network operator to combine licensed spectrum operations with access to unlicensed spectrum to opportunistically enhance users’ data rates,

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<sup>1</sup> *Office of Engineering and Technology and Wireless Telecommunications Bureau Seek Information on Current Trends in LTE-U and LAA Technology* ET Docket No. 15-105, Public Notice, DA 15-516 (OET & WTB May 5, 2015) (“Public Notice”).

performance, and experience. It offers a technology choice for offloading traffic using unlicensed resources, integrated with the licensed carrier's network. LTE-U/LAA is standards-based and designed to co-exist with other technologies using unlicensed bands, including 802.11/Wi-Fi.<sup>2</sup>

## **II. THE TRANSFORMATIVE NATURE OF OUR NETWORKED SOCIETY DEPENDS ON SOUND SPECTRUM POLICY**

The world is fast becoming what Ericsson describes as the “Networked Society,” where connectivity is the linchpin for new ways of innovating, collaborating and socializing.<sup>3</sup> The transition to this Networked Society represents a fundamental shift in technology comparable to the Industrial Revolution. It will create freedom, empowerment, and opportunity to transform industries and society while helping find solutions to some of the greatest challenges facing our planet.

In the Networked Society everyone and everything will be connected everywhere in real time—and that, of course, requires additional spectrum. Whether it is through solutions utilizing licensed, unlicensed, or shared spectrum, wireless communication is driving innovation and sparking new activities by individuals and organizations, by consumers and producers, leading to new functionality and new business models.

In this connection, LTE-U/LAA can be the next transformative step in the evolution of mobile communication, 5G. While no single technology is a one-size-fits-all solution to provide for

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<sup>2</sup> The term “Wi-Fi” is often used for both Wi-Fi certified equipment and non-certified 802.11 equipment. LTE-U/LAA is designed to coexist with any IEEE 802.11 WLAN regardless of whether it is Wi-Fi certified or not. We will use the term “802.11/Wi-Fi” to refer to this entire range of devices.

<sup>3</sup> See Ericsson, *Networked Society Essentials*, at 2-3 (2014), <http://www.ericsson.com/industry-transformation/wp-content/uploads/sites/6/2014/04/networked-societyessentials-booklet.pdf>; Ericsson, *Understanding the Networked Society*, at 2-3 (2015), <http://www.ericsson.com/res/docs/whitepapers/wp-understanding-the-networked-society.pdf>.

ubiquitous, expansive, mobile connectivity, LTE-U/LAA will help realize the vision of boundless access to information and sharing of data anywhere and anytime for anyone and anything – the Networked Society.

### **III. SKYROCKETING DEMAND FOR MOBILE DATA REQUIRES INNOVATION IN BOTH LICENSED AND UNLICENSED BANDS**

Ericsson’s most recent forecast projects that North American mobile data traffic will balloon 8 times by 2020,<sup>4</sup> and U.S. policy must embrace a combination of licensed and unlicensed spectrum initiatives if industry and innovators can hope to keep up. The mobile networks of today and in the future will need to use multiple, evolving aspects of licensed and unlicensed technologies to deliver the best mobile experience possible in any given environment.

Access to more licensed spectrum is a critical element, and Ericsson commends the Commission, NTIA, and others for the hard work that has brought us this far in repurposing spectrum for mobile broadband – but we all know more needs to be achieved. The ITU Radiocommunication Sector estimates that total mobile network spectrum requirements to meet traffic growth by 2020 will range from 1340 to 1960 MHz, depending on density.<sup>5</sup> The United States currently has 645.5 MHz of licensed spectrum for commercial wireless services.<sup>6</sup> Even with the 500 MHz of additional spectrum that the National Broadband Plan called for by 2020,<sup>7</sup> the total figure for U.S. commercial

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<sup>4</sup> *Ericsson Mobility Report*, at 13 (June 2015), <http://www.ericsson.com/res/docs/2015/ericsson-mobility-report-june-2015.pdf>.

<sup>5</sup> International Telecommunication Union, Radiocommunication Sector, *Future Spectrum Requirements Estimate for Terrestrial IMT*, Report ITU-R M.2290-0, at 14 Table 1 (Dec. 2013), [http://www.itu.int/dms\\_pub/itu-r/opb/rep/R-REP-M.2290-2014-PDF-E.pdf](http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2290-2014-PDF-E.pdf).

<sup>6</sup> Brattle Group, *Mobile Broadband Spectrum: A Vital Resource for the American Economy*, at 8 (May 2015) (“CTIA Brattle Group Report”), <http://ctia.it/1Er811x>.

<sup>7</sup> CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN, at 84 (2010) (“National Broadband Plan”), <http://www.broadband.gov/plan/>.

wireless spectrum would nonetheless fall 300 to 900 MHz short of the ITU-R’s estimate of industry needs.

In the face of growing demand, U.S. wireless carriers have engaged in continuous innovation and investment in new, more robust, more efficient technologies, with 2G systems evolving to 3G, 4G and soon 5G systems using flexible-use licensed spectrum. The smooth transition from one generation of technology to the next is based in part on innovations in many different technology areas, including advanced compression technologies and smart antennas that enable more intensive use of licensed spectrum bands.

Unlicensed spectrum, of course, is also an integral component for meeting the growing demand for mobile broadband.<sup>8</sup> Offloading traffic from mobile devices operating on licensed spectrum onto unlicensed spectrum has become vital: in 2014, 57 percent of U.S. mobile data traffic was offloaded through 802.11/Wi-Fi or femtocells, up from just 8 percent in 2010.<sup>9</sup> As one commenter noted, mobile network operators are embracing unlicensed bands, “not as an alternative to licensed spectrum, but as an expedient way to increase network capacity in dense areas that is complementary [to]—and fully integrated with—licensed spectrum.”<sup>10</sup> And more broadly, unlicensed spectrum has been a source of nearly as much innovation as licensed spectrum over recent years: 802.11/Wi-Fi is a testament to the creative spark that has changed the face of the unlicensed bands.

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<sup>8</sup> In these comments, the term “unlicensed” is used to refer both to Part 15-style unlicensed devices and licensed-by-rule services such as the 3.5 GHz General Authorized Access, which lack individual licenses or exclusive spectrum allocations.

<sup>9</sup> Cf. Cisco, VNI Mobile Forecast Highlights, 2014 – 2019 (United States – Device Growth/Traffic Profiles) and Cisco, VNI Mobile Forecast Highlights, 2010 – 2015 (United States – Device Growth/Traffic Profiles).

<sup>10</sup> Monica Paolini, *Analyst Angle: LTE in Unlicensed Spectrum and Wi-Fi, Looking Beyond Coexistence*, RCR Wireless News (Feb. 23, 2015), <http://www.rcrwireless.com/20150223/analyst-angle/analyst-angle-lte-unlicensed-spectrum-wi-fi-tag9>.

#### **IV. THE SUCCESS OF UNLICENSED IS DUE IN LARGE PART TO THE FCC'S LONGSTANDING POLICY OF TECHNOLOGY NEUTRALITY**

The story of unlicensed spectrum in the United States begins at one end with a commitment to technology neutrality and flexibility and continues today with ongoing innovation in unlicensed technologies. The Commission wisely pursued a path for unlicensed that maximized technological flexibility, within the limits needed to protect services from mutual interference, instead of allocating unlicensed spectrum for a particular use. By following this approach, the Commission has enabled product and service developers to push technology into uses that might never have been anticipated. As a result, unlicensed spectrum has opened up new possibilities not even imagined when the spectrum was made available. Commission policy should stay true to this approach. As the National Broadband Plan concluded, “[i]t is important to create a spectrum environment that provides plenty of room for experimentation and growth of new technologies to ensure that the next great idea in broadband spectrum access is first developed and deployed in the U.S.”<sup>11</sup>

The classic example of this is when the FCC established broad technical criteria permitting unlicensed use of a wide variety of spread-spectrum technologies in the Industrial, Scientific, and Medical bands.<sup>12</sup> The Commission’s very brief decision did not seek to favor particular uses of this spectrum, indicating only that spread spectrum in these bands may have “interesting civil applications” and will provide “important options for the communications system designer.”<sup>13</sup> It had no expectation that these bands would be intensively used for wireless

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<sup>11</sup> National Broadband Plan at 96.

<sup>12</sup> *Authorization of Spread Spectrum and Other Wideband Emissions*, GEN Docket No. 81-413, *First Report and Order*, 58 Rad. Reg. 2d (P&F) 251, 1985 FCC Lexis 4159 (1985).

<sup>13</sup> *Id.* at ¶ 1 n.1.

local area networks.<sup>14</sup> Yet, years later, this flexibility to innovate yielded a plethora of new products, including 802.11/Wi-Fi and Bluetooth,<sup>15</sup> utilizing different technologies for the Physical layer including Frequency Hopping Spread Spectrum, Direct Sequence Spread Spectrum, and Orthogonal Frequency-Division Multiplexing, which are today taken for granted.

The selection of technology should be a market-based decision made by vendors, service providers, and users, consistent with the limited technical rules governing unlicensed use. There is no basis for the Commission to grant preference to one technology over others. In particular, the coordinated use of licensed and unlicensed spectrum that LTE-U/LAA facilitates can and will coexist with other uses of unlicensed spectrum, including 802.11/Wi-Fi. The degree to which the spectrum is used for LTE-U/LAA, for 802.11/Wi-Fi, or for other purposes should be made by the market, not *a priori* by regulation dictating directions to the market.

Unlicensed bands should be open to all technologies within broad parameters. The Commission should not freeze technologies at their current level, which would deter continued innovation and investment in new technologies. Future improvements in efficient use of spectrum beyond current unlicensed technology, including LTE-U/LAA, should be allowed in the band as long as the technology conforms to neutral FCC rules. The Commission should not mandate, nor prohibit, particular technologies or standards. There should be no requirement to use a specified IEEE or 3GPP standard, which would place a particular standards body in the position of gatekeeper for all innovation and development in the unlicensed bands. Ericsson embraces a technology neutral

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<sup>14</sup> Thomas W. Hazlett and Evan T. Leo, *The Case for Liberal Spectrum Licenses: A Technical and Economic Perspective*, 26 Berkeley Tech. L.J. 1037, 1047 & n.41 (2011), <http://scholarship.law.berkeley.edu/btlj/vol26/iss2/4>.

<sup>15</sup> Bluetooth, invented by Ericsson in 1994, is a wireless technology using frequencies in the 2.4 GHz band for short-distance data transfers, such as connecting peripherals to devices wirelessly.



approach permitting 802.11/Wi-Fi, Bluetooth, LAA/LTE-U, and other future technologies in the 5 GHz band, the 3.5 GHz, the 2.4 GHz and other unlicensed bands.

**V. LTE-U/LAA PROVIDES A NEW PHASE OF INNOVATION IN THE UNLICENSED BANDS**

**A. LTE-U/LAA IS A KEY ENABLER OF GROWTH AND INNOVATION**

LTE-U/LAA embodies the innovation that Ericsson supports and the Commission should welcome. It is a synergistic combination of licensed and unlicensed spectrum use—employing unlicensed spectrum in close coordination with licensed service to provide additional off-loading capacity in lieu of requiring additional licensed spectrum. It enables substantially higher off-loading capacity for an improved user experience. At the same time, it is just another use of the unlicensed commons, with no greater or lesser claim to the spectrum than any other use.

As noted above, the need to find more ways to address ever-growing capacity demands is multiplying. LTE-U/LAA is part of the very flexible LTE platform that is evolving to address these new requirements (not only greater capacity demand but improved QoS parameters such as latency response). An LTE system, operating in the midst of an interference-limited environment, deploys complex techniques such as link adaptation, frequency domain scheduling, multiple-input-multiple-output (“MIMO”) technology, and inter-cell interference coordination (“ICIC”), to improve spectrum efficiency to the limits of computational power. LTE-U/LAA bridges the gap – delivering spectral efficiency while retaining the “politeness” necessary in the unlicensed bands.

**B. LTE-U/LAA IS A COMPLEMENT AND ALTERNATIVE TO 802.11/WI-FI, AND WI-FI WILL CONTINUE TO THRIVE**

Mobile broadband providers and others in the broadband ecosystem will continue to rely on expanded 802.11/Wi-Fi as an important method for delivering data traffic in the coming years.

Simply put, LTE-U/LAA will not “displace” 802.11/Wi-Fi in the unlicensed bands. As Verizon recently pointed out, it “has Wi-Fi in millions of its smartphones, tablets, mobile hotspots, and FiOS routers and has every incentive to ensure that LTE-U does not negatively affect customers.”<sup>16</sup> LTE-U/LAA will simply be an alternate solution to 802.11/Wi-Fi for offloading traffic for customers whose equipment supports it.

Further, LTE-U/LAA will not “overload” 802.11/Wi-Fi operations. Network operators deploying LTE-U/LAA are not creating new users or new traffic demands by adding this technology; they are simply using LTE-U/LAA for offloading traffic instead of using 802.11/Wi-Fi, both of which are used as complements to the licensed network. In other words, the demand placed on the spectrum by an LTE-U/LAA channel use comes from the user’s traffic, not from the technology employed. Without deployment of LTE-U/LAA technology, mobile network operators are likely to use the same band just as intensively under the 802.11/Wi-Fi protocol – perhaps more so as 802.11/Wi-Fi does not have the spectrum efficiency enhancements that are available under the LTE-U/LAA approach. In any event, 802.11/Wi-Fi continues to evolve, just as LTE does, and there will be competing technologies in unlicensed bands. The development of IEEE 802.11ax—promising multi-Gigabit speeds in the 5 GHz band—will improve the ability of 802.11/Wi-Fi to support capacity demands in the same manner as LTE-U/LAA does. This is the benefit of flexible unlicensed bands.

### **C. LTE-U/LAA WILL CO-EXIST WITH 802.11/WI-FI AND OTHER UNLICENSED TECHNOLOGIES**

LTE-U is designed, and LAA is under development, to ensure that the unlicensed spectrum remains available for other uses including 802.11/Wi-Fi—and in fact, LTE-U/LAA can

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<sup>16</sup> *Ex parte* letter from Kathleen Grillo, Verizon, to the Secretary, GN Docket 12-354 and ET Docket No. 13-49, at 1 (April 10, 2015).

be a better neighbor to 802.11/Wi-Fi than Wi-Fi itself is (see below). LTE-U/LAA implements a number of co-existence mechanisms to enable fair, shared usage of the spectrum. This is relevant, because the unlicensed bands do not belong to any one technology. Furthermore, LTE-U/LAA has a smart scheduling mechanism to distribute traffic in time among the licensed and unlicensed carriers in order to find transmission opportunities that optimize spectrum efficiency and avoid further aggravating congested traffic conditions. Therefore, with this enhanced level of coordination from a licensed carrier, LTE-U/LAA is able to maximize its coexistence with other uses in the band.

## **1. LTE-U**

LTE-U is compliant with 3GPP LTE release 12 and incorporates multiple co-existence mechanisms for fair, shared usage between LTE-U and 802.11/Wi-Fi operations, as well as between LTE-U operations. The same algorithm is used regardless whether the issue is coexistence with another LTE-U/LAA operator or a 802.11/Wi-Fi device. The LTE-U Forum<sup>17</sup> work utilizes the 3GPP-developed LTE standard but is performed independently of 3GPP timelines. It is not a “pre-standard,” as that implies that LTE-U still must be standardized. The LTE-U specifications are complete. The Forum’s technical specifications include minimum performance specifications for operating LTE-U base stations and consumer devices on unlicensed frequencies in the 5 GHz band, and coexistence specifications for fair sharing of spectrum among multiples technologies and users.<sup>18</sup> LTE-U specifications are freely available for review and open to any vendor to implement and develop.

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<sup>17</sup> LTE-U Forum, <http://www.lteuforum.org/>

<sup>18</sup> LTE-U Forum, LTE-U SDL COEXISTENCE SPECIFICATIONS v1.0 (Feb. 2015), [http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u\\_forum\\_lte-u\\_sdl\\_coexistence\\_specifications\\_v1.0.pdf](http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u_forum_lte-u_sdl_coexistence_specifications_v1.0.pdf).

The LTE-U Forum has initiated extensive technology discussions with many vendors and standards organizations that develop wireless solutions for unlicensed spectrum. Most recently, the LTE-U Forum conducted a full-day technical workshop with 29 companies and organizations participating, including IEEE and WFA. The workshop provided participants the opportunity to engage in a two-way discussion covering the details of the channel selection and LTE-U co-existence specifications, implementations, and test results with the workshop participants. As a result, the LTE-U Forum is incorporating revisions to the co-existence test scenarios and specification to provide an even more robust approach to co-existence.

LTE-U supports co-existence with 802.11/Wi-Fi by using Carrier-Sensing Adaptive Transmission (“CSAT”) to sense the traffic in the network, including how frequently the traffic materializes. The high-level functionalities now known as CSAT are described in Section 7 of the Forum Technical Report, which provides the Forum’s recommendations for a coexistence mechanism.<sup>19</sup> In essence, the sharing protocol uses a two-step approach: On startup, choose the least busy carrier, and share channel access time fairly with 802.11/Wi-Fi.<sup>20</sup> On the selected operation carrier, LTE-U will continue to monitor the received signal powers and traffic activities. According to the observed amount of traffic and the traffic patterns, LTE-U schedules bursts of traffic in the second step during those time intervals when other traffic is lower.

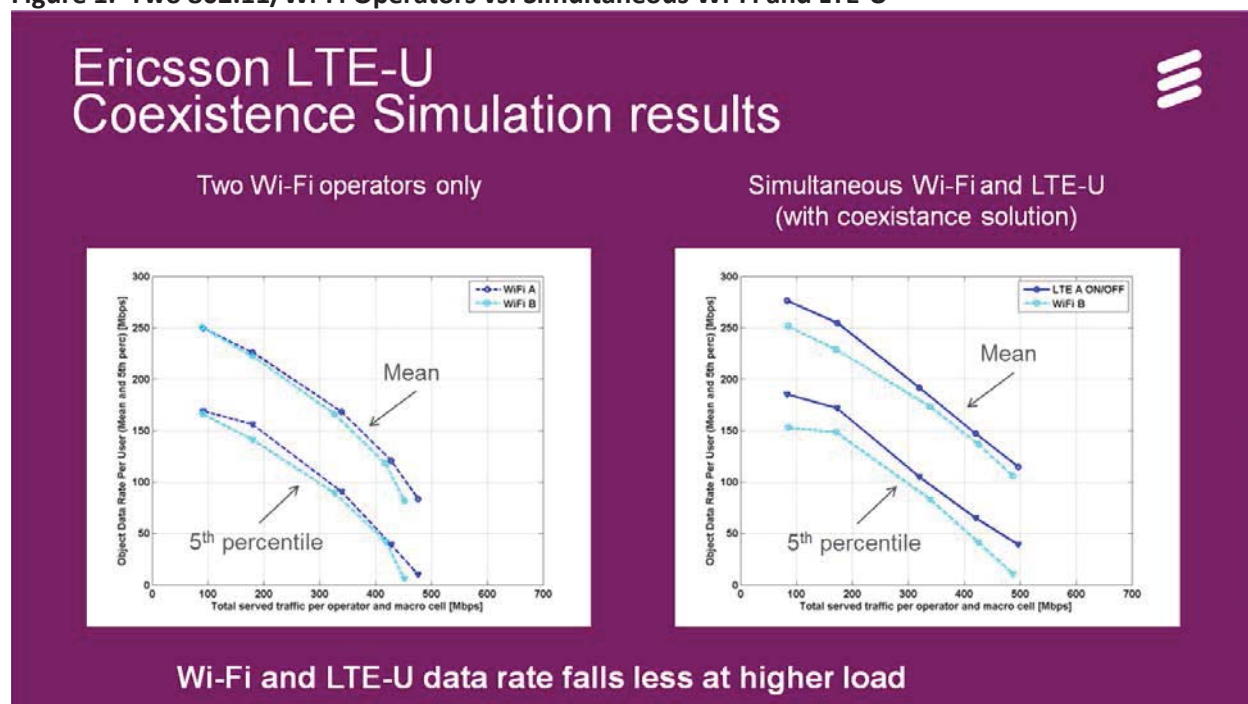
Ericsson has conducted tests comparing co-existence between two 802.11/Wi-Fi operations and between an LTE-U and 802.11/Wi-Fi operation:

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<sup>19</sup> LTE-U Forum, *LTE-U TECHNICAL REPORT: COEXISTENCE STUDY FOR LTE-U SDL v1.0*, at 42-43 (Feb. 2015) (“Forum Technical Report”), [http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u\\_forum\\_lte-u\\_technical\\_report\\_v1.0.pdf](http://www.lteuforum.org/uploads/3/5/6/8/3568127/lte-u_forum_lte-u_technical_report_v1.0.pdf).

<sup>20</sup> Ericsson, *LTE License Assisted Access*, at 7 (Jan. 2015), [http://www.ericsson.com/res/thecompany/docs/press/media\\_kits/ericsson-license-assisted-access-laa-january-2015.pdf](http://www.ericsson.com/res/thecompany/docs/press/media_kits/ericsson-license-assisted-access-laa-january-2015.pdf).

Figure 1. Two 802.11/Wi-Fi Operators vs. Simultaneous Wi-Fi and LTE-U



As the graphs demonstrate, when LTE-U shares spectrum with 802.11/Wi-Fi, Wi-Fi performance is actually *improved* as compared to when one 802.11/Wi-Fi operator shares with a second Wi-Fi operator. There are similar test results in the LTE-U Forum Report.<sup>21</sup>

The LTE-U specifications support LTE operation in the 5 GHz UNII-1 and UNII-3 bands, in conjunction with an LTE deployment in licensed bands. LTE-U is in full compliance with FCC rules governing the relevant 5 GHz UNII-1 bands. LTE-U will not degrade 802.11/Wi-Fi performance and will share spectrum in accordance with the rules of the band.

## 2. LICENSED-ASSISTED ACCESS USING LTE

Ericsson notes that LAA is based on 3GPP LTE Release 13, which will improve and enhance LTE in several aspects, including improved support for low-cost and energy-efficient machine-type communications through reduced RF bandwidth. In Release 13, LAA will include listen before talk ("LBT") and will incorporate certain regional-specific regulatory requirements

<sup>21</sup> LTE-U Forum Report at 42.

that address specific regulatory environments. LTE Release 13 is expected to be finalized this year.

The work in the 3GPP Rel-13 LAA Study Item has resulted in a Technical Report 36.889 v.1.0.0 summarizing the findings and conclusions from the Study Item.<sup>22</sup> The Study encompassed twelve working group meetings across the 3GPP RAN1, RAN2 and RAN4 working groups over the span of nine months. More than 40 companies participated in extensive technical discussions as part of the 3GPP study. Over 1500 technical contributions were submitted to 3GPP meetings during the study.

The coexistence evaluation was based on a rigorous two-step approach. In Step 1, performance metrics for two 802.11/Wi-Fi networks coexisting in a given evaluation scenario were evaluated and recorded. In Step 2, 802.11/Wi-Fi was replaced with LAA for the group of eNodeBs and user equipment served by one of the 802.11/Wi-Fi operators. Performance metrics of the 802.11/Wi-Fi network coexisting with the LAA network were evaluated and recorded. A comparison of the performance metrics between the two steps for the 802.11/Wi-Fi network that was not replaced with LAA can be used to evaluate coexistence between LAA and 802.11/Wi-Fi in an unlicensed band. Detailed analysis of the more than 350 coexistence evaluation reports from participating companies can be found in Section 8.3 of the Technical Report. The Technical Report concluded that LAA achieves fair coexistence with 802.11/Wi-Fi and with itself based on the evaluated scenarios. In addition, the Technical Report notes that “a study has also shown that LAA downlink and uplink can be supported in light of results related to major

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<sup>22</sup> 3GPP TR 36.889, *Study on Licensed-Assisted Access to Unlicensed Spectrum (Release 13)*, v.1.0.0 (May 2015), [http://www.3gpp.org/ftp/tsg\\_ran/WG1\\_RL1/TSGR1\\_81/Docs/R1-153690.zip](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_81/Docs/R1-153690.zip).

aspects of LTE radio interface architecture, protocol termination, radio interface protocols” between user equipment and radio access network and radio resources management strategies.<sup>23</sup>

There has been extensive coordination between 3GPP and IEEE 802.11 on appropriate sharing characteristics to ensure co-existence between LTE-U/LAA and 802.11/Wi-Fi. Communication between the two standards bodies is via liaison statements as well as presentations in person by the 3GPP RAN chair and the study item rapporteur directly to IEEE. 3GPP has incorporated revisions to evaluation scenarios and assumptions based on these liaison inputs. Furthermore, many of the important stake holders in the IEEE are participating as contributors in the 3GPP study directly and all agreements in 3GPP RAN WG1 are taken by consensus.

## **VI. CONCLUSION**

Ericsson is committed both to LTE-U/LAA and to 802.11/Wi-Fi and their ongoing evolutions. Ericsson supports technology neutrality to promote the very innovation the Commission envisions in the 5 GHz and 3.5 GHz bands, as well as elsewhere. The development of LTE-U/LAA is in line with free market principles, and represents exactly the kind of innovation needed for unlicensed bands. Indeed, the need for co-existence between LTE-U/LAA and 802.11/Wi-Fi has caused market-driven innovation that the Commission should encourage, because such innovation is the key to sharing and co-existence in additional bands in the future. Standards-based technologies such as LTE-U/LAA will evolve for global use, and the Commission should take care to continue to promote innovation and new technologies in unlicensed spectrum.

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<sup>23</sup> *Id.* at 75.

Respectfully submitted,

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